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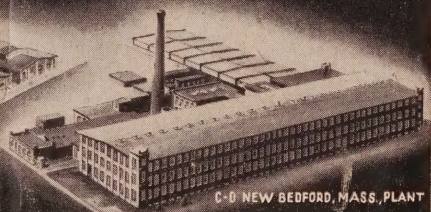
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Vol. 15

MAY, 1950

No. 5

CORNELL-DUBILIER ELECTRIC CORP.
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THE MAGNETIC AMPLIFIER

Since the close of World War II, the magnetic amplifier (also called the transductor) has attracted a steadily increasing amount of attention in private electronic circles. This has been due in large part, perhaps, to a carry-over of wartime interest in the device for control purposes in military equipment. Today, a host of applications in private industry suggest themselves.

Although the magnetic amplifier is a simple, tubeless device, it affords useful power amplification which in some cases is tremendous. Because it requires no tubes and can be operated with a straight a. c. power supply, it needs little or no maintenance and is capable of instant operation.

We are presenting a simple explanation of the magnetic amplifier in this issue of "The Capacitor" because we believe that this device will be encountered more frequently in future radio and electronic equipment and that its principle of operation therefore should be understood by radio and electronic technicians.

Basic Operating Principle

The magnetic amplifier owes its existence to the simple saturable reactor. Most radio men are familiar to some extent with saturation in reactors. They understand, for example, that the inductance of an iron-core choke coil is lower when a direct current flows through the coil than when no d. c. is present. (One commercial audio choke intended for impedance coupling in pentode plate circuits has an inductance of 200 henries when no d. c. is present in its coil, and only 50 henries when 2 milliamperes d. c. flow through it). This ability to change the inductance of an iron-core coil (and consequently its reactance and impedance to a. c.) by passing a direct current through the coil is the basic mechanism of the magnetic amplifier.

Figure 1 shows a rudimentary saturable reactor arrangement for explanatory purposes. Two windings, A and B, are situated on the same iron core, in the manner of a standard transformer. A constant-level a. c. voltage

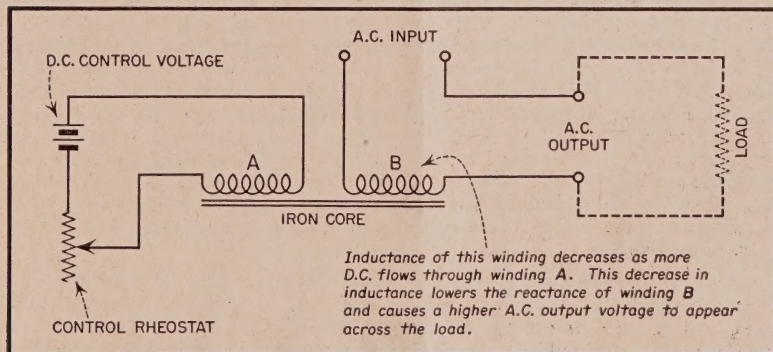


Fig. 1. Saturable Reactor Principle.

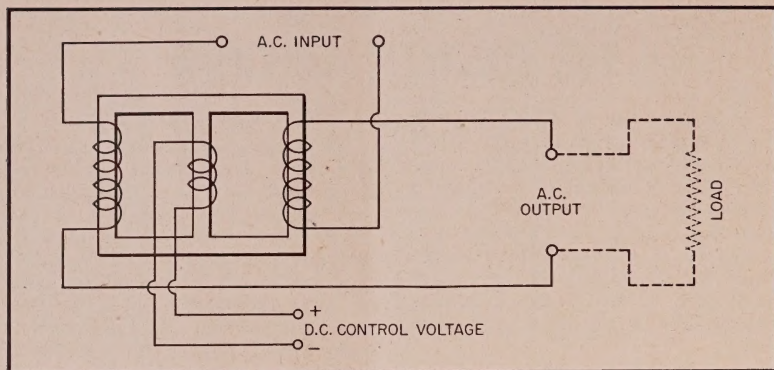


Fig. 2. 3-Leg Saturable Reactor.

is applied in series with winding B and a load device, such as a resistance. Winding B thus acts as a series reactor in this circuit and can limit the value of the a. c. output voltage. The a. c. output voltage is equal to the a. c. input voltage minus the voltage drop in winding B (vectorially). The reactance of winding B depends upon the inductance of this winding, and that in turn depends upon the size of the winding and the nature of the core material and its condition. If the core is "premagnetized" (for example, by passing a steady direct current through winding A), the inductance and reactance of winding B will not be as large as when no current flows through A. The result is that winding B will offer less impedance to the applied a. c. input voltage, and the a. c. output voltage will increase. Up to a certain point determined by the magnetic properties of the core material, the more direct current flowing in winding A the higher will be the a. c. output voltage.

By properly proportioning windings A and B and the a. c. and d. c. voltages, and by selecting properly the core material, it should be possible to vary the a. c. output voltage over a

range extending from nearly zero to a maximum value. Also, it should be possible to use a relatively small amount of d. c. power to control a rather large a. c. power. This, of course, amounts to power amplification, and when it can be accomplished with apparatus of the type just described, a magnetic amplifier results.

While the illustration in Figure 1 serves to explain the principle of the saturable reactor which is at the basis of the magnetic amplifier, it has necessarily been oversimplified. Some difficulties would, of course, be experienced with such rudimentary equipment. For example, the amount of magnetization obtained from winding A would not be great unless the core were of the size and material to give good efficiency. Also, the transformer action would cause an a. c. voltage to be induced from winding B across the terminals of winding A. This induced voltage very likely would interfere with application of d. c. to winding A.

A practical form of saturable reactor, such as is found in industry, is shown in Figure 2. Here a special 3-legged core is used. The a. c. winding is divided into halves, one being

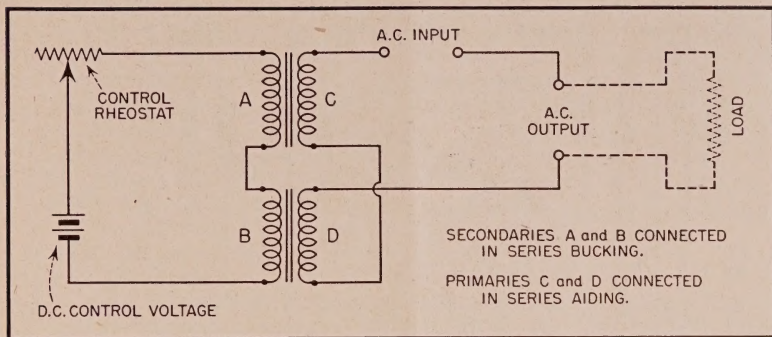


Fig. 3. Transformer-type Magnetic Amplifier.

wound on each outside leg of the core. The two halves of this winding are connected in series aiding. The d. c. control coil is wound on the center leg of the core.

With this arrangement, no a. c. is induced in the d. c. coil because the magnetic flux arising from the a. c. coils extends around the rectangle of the core but not through the center leg. Flux due to d. c. flowing through the control coil, however, extends from the center leg through both outer legs and accordingly can affect the reactance of the a. c. coils. This forms a saturable reactor of the type which has been employed for a num-

ber of years for theatre light dimming, motor control, relay operation, voltage regulation, and for tuning-light operation in radio receivers. This is a form of magnetic amplifier, since with proper design the controlled power may be large compared to the controlling power.

Figure 3 shows a simple saturable-reactor-type amplifier or control circuit utilizing two small 2-winding transformers. This arrangement has been popular with students and experimenters. Miniature transformers having nickel alloy cores are especially suitable for this application, since such transformers are not designed to

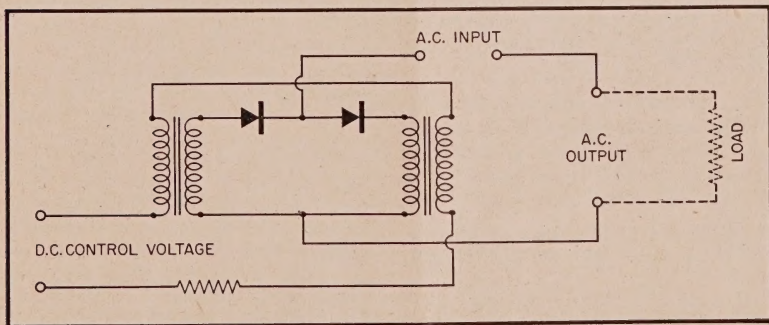


Fig. 4. Self-excited Transducer.

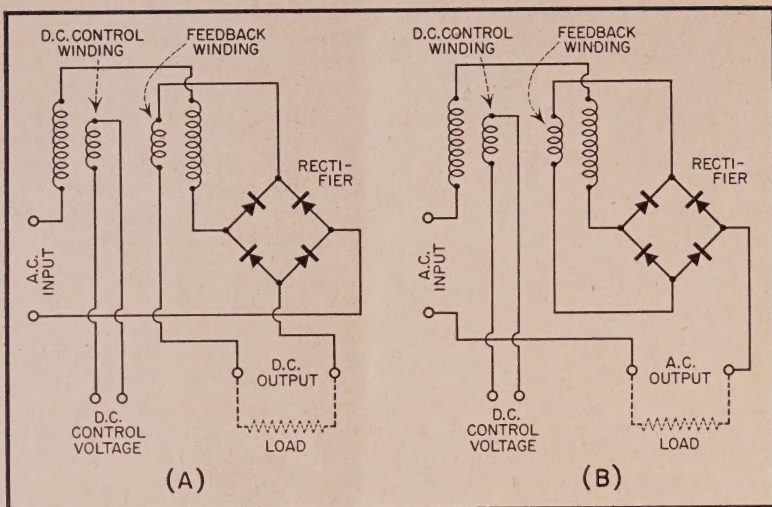


Fig. 5. Feedback Amplifiers.

handle appreciable direct current and therefore are readily susceptible to the d. c. control current.

The d. c. control voltage is applied to the two secondary windings (A and B) which are connected in series bucking. This opposing type of connection cancels any a. c. induced by the windings C and D, preventing its being forced through the d. c. source. The a. c. supply voltage is applied in series with the primary windings C and D (which are connected in series aiding) and the load.

Magnetic Amplifier Types

The Swedish engineers Hedstroem and Borg have shown a circuit¹ in which the core is presaturated in order to position the point of operation

¹ *Transducer Fundamentals*. Hedstroem and Borg. *Electronics*, September, 1948. p. 88.

² *Magnetic Amplifiers*. (Bulletin No. VT-2000). Vickers, Inc., St. Louis, Mo. pp. 6, 7.

along an advantageous part of the permeability curve of the core material. In order to prevent having to use a separate presaturating winding and d. c. source, a portion of the a. c. supply is rectified by two metallic rectifiers and used for this purpose. A form of this circuit is shown in Figure 4. Selenium rectifiers normally are employed, but germanium diodes might be used for light-duty applications.

Two interesting applications of feedback to magnetic amplifiers are shown by Vickers² and are illustrated in Figure 5. In each of these circuits, a separate winding is provided for feedback. Direct current for this feedback winding is obtained from a full-wave bridge rectifier composed of metallic cells or diodes and operated in series with the amplifier load. Figure 5 (A) shows a feedback amplifier circuit which delivers d. c. output to the load. This then is a d. c. amplifier. Figure 5 (B) is a similar circuit which

delivers a. c. to the load. In each of these drawings, only coils are shown. The core has been omitted for simplicity of reading.

Depending upon the polarity of the feedback winding, either positive feedback (regeneration) or negative feedback (degeneration) can be obtained. The effect of regeneration is to increase the sensitivity of the amplifier to small changes in the d. c. control voltage. The effect of degeneration is to make the response more linear and to increase stability, although (as in electronic amplifiers) degenerative feedback reduces the sensitivity somewhat.

Any of the conventional magnetic amplifier circuits may be used as an a. c. amplifier by rectifying the a. c. signal voltage, applying the resulting d. c. to the d. c. control winding, and taking a. c. output from the amplifier. Similarly, a d. c. amplifier may be made by feeding the d. c. signal voltage directly into the control winding, and rectifying the a. c. output of the amplifier. The third type of operation which perhaps is most common in magnetic amplifier usage (and which is employed almost exclusively for control operations) consists of applying a d. c. control voltage and taking a. c. output from the amplifier.

Magnetic amplifiers may be operated in cascade, in the same manner as tube amplifiers, in order to obtain higher gains. They also may be operated in pushpull.

Only basic circuits are shown in this article, since our discussion is of an introductory nature. We will not touch upon polyphase magnetic amplifiers nor show multi-stage circuits.

Magnetic Amplifier Applications

The magnetic amplifier has no moving parts; and since it has no tubes

which must heat up slowly, it is ready for operation as soon as it is switched on. Mechanically rugged, it can withstand considerable abuse. In most installations, the magnetic amplifier is no more bulky nor unconventional in appearance than any iron-core transformer or choke of similar ratings. Replacement and maintenance costs are low for this device.

The magnetic amplifier has the disadvantages that it does not have the speed of operation of the electron tube amplifier or control circuit. Its speed depends upon inductance and frequency. The magnetic amplifier places a load upon the control-signal source, since it draws current for control. Its high frequency limit is governed by the electrical and magnetic characteristics of the core material. It is expected that newly developed core materials may extend the operating range ultimately into the radio-frequency spectrum.

Within the limits of its operation, the magnetic amplifier provides exceptional stability in both a. c. and d. c. applications. Hedstroem and Borg¹ report power amplifications as high as 100 million. The magnetic amplifier makes a good non-mechanical relay or trigger capable of handling high power levels directly, finds use as a current transformer and as a translator in telemetering, may be used as a voltage regulator and as a general-purpose sensitive electronic control device controllable by phenomena as low-powered as the output of a photocell. Additional uses which are of interest are low-frequency audio amplifier, motor control, low-frequency oscillator, controlled-output rectifier, and audio modulator.

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All ads are published in the order received, but those held over two issues are discarded. Every effort will be made to include your ad either in the issue being prepared or the succeeding number, but will be automatically dropped thereafter.

SELL OR TRADE—Acme 35mm silent motion picture projecture, Army raft, trombone, cornet, Army BC-222 Walkie-Talkie, want 2 1/4 x 3 1/4 Peacemaker Speed Graphic press camera, trap drum set or cash. Russell Boshart, Olds, Iowa

WANTED—Radio News for May, 1946, January, 1947 in suitable condition for binding. W. A. Rush, 444 Eastern Ave., Indianapolis 1, Ind.

FOR SALE—Presto K-8 portable disc recorder, excellent condition, complete (less mic.), \$275. RCA chanalyst, good working order, pre-war, cables, etc., \$95. Ernie Garrison, Sistersville, W. Va.

SALE OR TRADE—Recorder, Presto K8, \$275 with 4 13 1/4" recording blanks (soundcraft); new Shure 51 sonodyne mike, stand, \$20; new Pulpit Boom mike stand, \$5, or trade for 16mm movie projector. H. Dramer, 3943 Boundary St., San Diego,, Calif.

WANTED — Position. Electrical engineer grad Jan., 1950, year experience production control, year experience repair, test: receivers, transmitters, etc. Seeks to be junior engineer. D. Robbins, 1795 Longfellow Ave., Bronx, N. Y.

FOR SALE—Burkaw RK-41 portable recorder, hardly used, \$60. Emerson 3-way FU-427 portable radio, perfect working order with batteries. Best offer. R. Mendelsohn, 961 Jefferson Ave., Brooklyn 21, N. Y.

FOR SALE—Meissner analyst, \$119.50, take \$60, good condition; Supreme 542 multi-meter, \$15, good condition. Bud's Radio & Television Service, 5912 Hampton Blvd., St. Louis 9, Mo.

TRADE—McMurdo Silver Masterpiece VI 18" Jensen speaker, extra set of tubes. Receiver, cabinet in good condition. Will trade for good shortwave receiver. Andrew Sender, Mary St., Shelton, Conn.

SWAP OR SELL—BC-454-E Command receiver, PE-120-B vibrator power supply; 6, 12, 24 v. input, 90 and 145 V.D.C. output. Trade for short-wave receiver or test equip. or cash. S. A. Campbell, 208 Jackson Ave., Schenectady 4, N. Y.

SELL OR TRADE—More than first half of radio course by Nat. schools (taken in 1948), 5 motor, rachets ARN-7 band-switch assemblies. Want electric drill or what have you? G. N. Manning, 205 W. Walnut Ave., Dalton, Ga.

TRADE—Latest DeForests radio-TV course, Craftsman bench woodworking vice and magnetic jig saw for test equipment. What have you? J. G. Perkovich, R 1, Waldo, Wis.

SALE OR TRADE—Console Magnavox AM-FM radio, including Collins FM-11 tuner, 3-speed Webster changer, Scott suppressor, preamplifier; 24 tube total. Set price. Curtis Campbell, 511 North Franklin, Kirksville, Mo.

FOR SALE—Linear standard audio transformer LS-21, \$8; Astatic FL-33 micro-groove pickup, \$4; Garrard RC-60 intermix record changer, \$25. All excellent condition. Jack Atkins, 1375 27 St., Ogden, Utah

FOR SALE—R.C.P. model 668, V.T.V.M. with complete set of heavy duty test leads, almost new, \$55 postpaid. Have other test instruments and radio parts. Johnnie Lane, Tutwiler Radio Service, Tutwiler, Miss.

WANTED—Kit or used 3" or 7" TV set for experiments and study. Waite's Radio Service, Rising Sun, Md.

SALE OR TRADE—Hallicrafter receiver SX-16, matching speaker, good condition; 400 EA beam. Best offer or trade for good TV receiver. Give description. Ralph Jester, 564 Round Lake Dr., Michigan Center, Mich.

FOR SALE—Air King portable wire recorder with phono combination complete with 3 one hour spools, perfect condition, \$75. W. C. Berman, 1188 Broadway, Brooklyn 21, N. Y.

SELL OR TRADE—Precision E200C signal generator, Sprague de luxe tel-ohmike and hi-fi phono. equip. Built by professional, perfect working cond. \$45 takes it f.o.b. Need portable transcription player. Carl Stahnke, Aitkin, Minn.

FOR SALE—Whizzer bike motor in good condition, worth \$35. Want test equipment. All letters answered. Arnold's Radio & Television, Minck Ave., West Berlin, N. J.

SWAP—Philco TV set, model 48-700, good operating condition. Make me an offer. George Chigi, 339 Seaman St., New Brunswick, N. J.

TRADE—RCA radio marine communications receiver AR8506B (mfg. April '44), freq. 85-550KC1.9-25MC. Want rifle, shotgun, swords, bayonets, daggers, etc. Ed Agramonte, Harrison, N. Y.

FOR SALE—Proceedings of IRE for 1948, 1949; 16 books on radio, TV, microwave engineering, math., excell. cond., latest edition, most books of college level. D. P. Cordell, 9511 Jackson Ave., Brookfield, Ill.

FOR SALE—1-5 Riders guides, radio books. Will send list. Bound copies of QST, Radio News. R. H. McConnell, P.O. Box 43, Grandview, Wash.

WANT—Marine radiophone equip., including crystals, antennas, for small craft ship-to-shore installation, also marine radio direction finder. Give details in first letter. R. H. Ives, 663 Kempsville Rd., Norfolk 2, Va.

FOR SALE—Sylvania polymeter, type 134, complete with test leads, RF probe, instruction book, \$72.50; Triplett tube tester model 3413, instruction book, \$55; both like new. R. J. Schaufert, 3514 Erdman Ave., Baltimore 13, Md.

SWAP—2 Neon trans. 6000 and 7500 v. sec., BC 455 set, Airline small 5 tube set; photo developing set; Ungar iron 2 tips. Want small or large amplifier. T. Rohland, RR 1 Paragon, Ind.

FOR SALE—Scott 30 tube Philharmonic chassis complete with amplifier and 15" speaker, 6 hand tuning, \$85. A. J. Talbot, 2334 First Ave., N. E., Atlanta, Ga.

SWAP OR SALE—RCP sig. gen. 710 and RCP multimeter 449, cabinet to house both. Want to swap for BC 412 radar-scope or cash. Gene Mick, P.O. Box 1, Buckingham, Pa.

SALE OR TRADE—Rider manuals, vols. 6-14; TV vol. 1; Auto. record changers, recorders, vol. 1; master index for vols. 1-15. Cash or trade for communications receiver. C. E. Gumley, 113 Third St., N. Charleston, S. C.

FOR SALE—Radio-TV parts and tubes; back issues of leading radio, FM, TV, Electronics magazines. Send stamped envelope for list. J. J. Faso, 67 Sycamore St., Massapequa, N. Y.

FOR SALE—7" Philco mahogany table model 48-700 TV set, A-1 condition. Make offer. O. Radhe, 3801 N. Newhall St., Milwaukee 11, Wis.

WANT—4" or larger Jewell or Weston meter with 1 mill movement and volt-ohmmeter scale. H. A. Rollins, 113 Central Park Dr., Brownsville, Texas

SWAP—Model 110 Bendix radio for Instructograph and tape. W. C. Hanks, 912 S. Ave. H, Crowley, La.

FOR SALE—Geiger counters, 1.4 lbs. complete with batteries and lightweight phones, \$32.50; heavy duty unit, 2.8 lbs., \$45. J. Bourke, East Rockaway, N. Y.

FOR SALE—Model 51 Shure Sonodyne dynamic mike, \$25. Dale Matousek, St. Paul, Neb.

FOR SALE—Brush soundmirror magnetic wire recorder-reproducer, model BK 303, with acoustical BA-106 mike, two 3-hour spools of wire. Studio recorder. List over \$700. Offer? Edward Kimmel, 1807 Hartman Ave., Louisville 5, Ky.

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FOR SALE—NRI radio tube tester, used little, excell. working cond., \$45. L. Bates, Reservoir St., Holden, Mass.

FOR SALE—Rack mounted VFO. BC696 and BC459 using regulated power supply with 1100 v., 300 ma xfmr.; pair 200 ma chokes; 5Z3, 2-6A3, 6SJ7, VR75; 3 extra xfmrs, etc., \$55. P. K. Eckman, 1208 Romine Ave., McKeesport, Pa.

FOR SALE—Triumph model 500, condenser bridge analyser, \$10 f.o.b. Checks capacity, resistance, coils and resistance inductance. National Radio Service, 379 Merritts Ave., N. E., Atlanta 5, Ga.

FOR SALE—Supreme sig. gen., model 580 Deluxe series, excellent cond., \$20, express collect anywhere. E. T. Morton, Radio Service, 31 Market St., Potsdam, N. Y.

WANT—Small commercial (preferred) or custom made 50 w. lone, CW xmt, with power supply, coils, tubes, ready to go; 1 unit. Trade or buy. J. A. Smith, 719 Jordan St., Jacksonville, Ill.

FOR SALE—Hallicrafters receiver Skyriders 32 with schematic, Webster amplifier, type 50B12, other radio parts. All used but in good condition. Send for list. E. D. Armstrong, 1197 First St., Los Alamos, N. M.

FOR SALE—Meissner FM tuner, model 8C, like new, best offer over \$30. H. D. Steedly, Jr., Bamberg, S. C.

FOR SALE—Issues of QST, 1922 and later. F. J. Cady, Box 616, Amsterdam, N. Y.

FOR SALE—150 radio parts, all usable, no junk. Antenna coils, oscillator coils, choke coils, volume controls, switches, condensers, resistors, trimmers, \$2. Williamson Radio Service, Cooper, Tex.

SALE OR SWAP—Army model super-pro 14 tubes, crystal filter, 540 KC to 20MC, home built 10 meter broad band converter (6J4, 6J6), power supply, cash or TV receiver. Martin Herbstman, 1806 Sterling Pl., Brooklyn 33, N. Y.

FOR SALE—RCP Hi-Meg multitester, model 450A with leads, new, oak case; Triplett tube tester, mdl. 2413, test all tubes, \$50 takes both. Thomas Byrne, 24 Linden Ave., Bronx 61, N. Y.

FOR SALE—Riders manuals, 1, 5-16, with how it works sections, index, little used, good cond. Sell as set, you pay express charges, \$75. N. W. Foster, 47-13 44 St., Woodside, L. I., N. Y.

SALE OR TRADE—25 w. P. A. amplifier, automatic record player for 10", 12" records; model 11A audio development pre-amplifier; dental vulcanizer, all good cond. Want battery eliminator, etc. D. B. Fritz, Bethlehem Pike, Colmar, Pa.

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FOR SALE—Supreme model 576 sig. gen., Supreme model 599 tube, set tester with latest roll chart, 9 pin tube socket, both like new, \$75. G. C. Barkoukis, 712 Fraze Ave., Akron 5, Ohio

FOR SALE—ART 13, bought new, converted for 20-40-80, 28 v. power supply, \$175. D. J. Meade, 111-25 202nd St., Hollis, L. I., N. Y.

FOR SALE—Audax microdyne hi-fidelity pickup, model PRO-2 with UTC quadruple shielded matching transformer, model LS-12X worth \$78, best offer taken. J. W. Buchspies, 172 Myrtle Blvd., Larchmont, N. Y.

WANT—Schematic circuit diagram for Triplett volt and OMM test meter, model 321. Write. Nathan Scaggs, Box 1176 Denton, Tex.

FOR SALE—Meissner 7 tube radio phono and recorder, 2 speed motor, like new, \$65. Riders manuals, 1-11, like new, 40% off. Juel's Radio Service, Farwell, Neb.

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SALE OR TRADE—S-40 receiver, Thordarson CHT mod xmfr T-11-M-75, pair 811's, new. Want BC-221 with cal. book, mod. pfd. W. Zuehlke, R 7, Box 356, Akron 3, Ohio

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SWAP—Radio tubes. Send list of what you have (marked new or used) for what you need. Enclose \$1 for detail work. Swap approvals or list of other swappers (will be returned). F. Cabon, 1504 Labaig, Los Angeles 28, Calif.

WANTED—Old or junked auto radios. Will swap. Send for list or send data on model, make, type, price. Andy's Radio Service, 1114 Idaho St., Norman, Okla.

WANT—Meissner analyst or Rider channel, oscilloscope battery eliminator for car radios, other test equip., in very good cond. Send description, condition, price. John Korpita, 513 Morgantown Ave., Fairmont, W. Va.

WANT—Tube tester and oscilloscope. Radio Robert, Haven's Drive-In, Hannibal, N. Y.

WANT—Code practice machines or tapes, new or used. Murray Ludzki, 1214 Vyse Ave., Bronx 59, N. Y.

WANT—Wire recorder magazines for Sig. nal Corps model MX-303-A/ANQ-1 and Navy model VRW-1, magazine of Brush Development Co., Cleveland, Ohio. H. L. Otis, 12204 E. Leffingwell Rd., Norwalk, Calif.

FOR SALE—H. H. Scott dynamic noise suppressor, \$25; 30 w. amplifier, push-pull 6L6 output, non-inductive feedback, mike, tuner, phono input, etc., \$45; G.E. preamp., \$3.50 or all for \$69.50. R. C. Barley, 61 Chesnut St., Wyandotte, Mich.

FOR SALE—Portable record player. 78 rpm only, in PA-10 case, has Shure Glider pickup, Alliance motor, 5" speaker. Perfect working cond., \$15 f.o.b. Hein Radio Service, 418 Gregory St., Rockford, Ill.

FOR SALE—Weston photoronic light cell, \$4.50; Perco FM tuner with solid walnut cabinet, \$9.50. Benny Leotta, 1625½ S. First, Springfield, Ill.

FOR SALE—RME-45 receiver, like new, best offer gets it. Ray Doornbos, 2529 Brook Dr., Kalamazoo, Mich.

FOR SALE—National NC-57 receiver, like new, original packing box, best offer over \$65. H. D. Vorhauer, 231 So. Main, Chincoteague, Va.

SELL OR TRADE—Instructograph, electrically operated; tapes; radio books used at RCA Institute. John Kalenak, 169 Washington Park, Brooklyn 5, N. Y.

FOR SALE—TV set in excellent, like new condition. Will sell cheap. H. Latko, 1922 Dickens, Chicago, Ill.

SELL OR TRADE—SW-3; SX24; SX28; HRO; Super Pro, all in good condition; 4 H 900Ma chokes; 16H 450Ma chokes. Trade for ham gear or photography gear. George Sue, 701 8th St., Modesto, Calif.

WANT—Power supply for operating auto radios. Must be reasonable. G. Hatten-dorf, 5751 Wintrop Ave., Cincinnati 24, Ohio

SWAP—Radio equipment, tubes, etc. for photo or movie equipment. Peter Calderaro, 20 Richardson St., Wakefield, Mass.

WANT—5 x 8 Kelsey press, small 5 tube radios in any cond., TV booster (ch. 4), TV sets, new standard brand tubes. Ben's Radio, No. Tonawanda, N. Y.

WANT—TV sig. gen, Superior model TV-30 or Precision model E 200 C. Have cash, test instruments to trade or what have you? John Arnold, P. O. B. 84, Bluffs 3, Ill.

WANT—TV, similar to Philco 48-1000. State condition and price. E. N. Christner, 313 Crawford St., Middletown, Ohio

FOR SALE—Radio and electrical books. write for list and prices. John J. Levine, 15-17 Kelley Square, Worcester 4, Mass.

WANT—Carrier intercom operating on r. f. with output into house electric line. Specify details. S. Gross, 326 E. 96 St., Brooklyn 12, N. Y.

SWAP—32 back issues of Radio Craft, no covers. Want typewriter or what have you? J. E. Visco, 499 Pleasant St., Watertown 72, Mass.

WANT—Good signal tracer and complete schematic for Silver Marshall model 30. State price. Will trade new 13 piece drawing set, complete, cost \$35 but sell for \$20. Harvey Nations, Western Carolina Teachers College, Cullowhee, N. C.

FOR TRADE—Riders manuals, vols 10, 11, 13, 14, 15 for good com. rec. R. Chambers, 13833 San Antonio Dr., Norwalk, Calif.

WANT—Will pay \$75 cash for Riders manuals 10-18, inclusive. Must be in reasonably good cond. Latham Radio Shop, Cuba City, Wis.

SELL OR TRADE—Home made CW transmitter and 19" relay rack. Coils, tubes, extra panels included. Complete. Want communications receiver. R. A. Lynn, Medford, Okla.

FOR SALE—NC57—FB condx, \$65. A. R. Vaught, 4513 Mellwood Ave., Cincinnati 32, Ohio

SELL OR TRADE—3 Zenith automatic record changers, with Cobra arm. Pre-amp included. Sell for \$30 each or trade for photo or ham equipment. Joseph Bruner, 311 S. Harris St., East Point, Ga.

SELL OR SWAP—Heathkit VYVM, \$32.50; RCP sig. gen. model 710, \$10. Bud's Radio Service, 1212 N. Shabbona St., Streator, Ill.

WANTED — Combination VTOM and tube tester. Cash or trade. What do you need? M. R. Hemby, 1240 Green St., San Francisco 9, Calif.

FOR SALE—Riders manuals, vols. 1-4, \$7; G.E. tube tester, mod. TC3, \$22; Supreme oscilloscope, No. 546-A, \$37. E. McGee, 41 Birch St., Worcester 3, Mass.

FOR SALE—Meissner model EX sig. shifter complete with FMX phase modulator, in cabinet but will include extra Meissner relay rack panel. \$50 f.o.b. 443 Saratoga Rd., Schenectady, N. Y.

FOR SALE—Kodack Recomar camera complete, exposure meter, filters, flashgun, floodlights, tripod, etc. Complete dark-room equip. Sell as unit for 30 tube TV set. Make offer. James Littig, Kasota, Minn.

WANT — Good amateur receiver. Have Howard 445 com. receiver, .22 rifle, 12 ga. double barrel, High Standard target pistol and holster, Johnson racer, ice skates (size 9), etc. E. W. Barth, 333 Washington, Chelsea, Mich.

FOR SALE—Perfect copy of "Elements of Acoustical Engineering" by Olson. Only \$3. First come, first served. Leon Medler, 2109 Daly Ave., Bronx 60, N. Y.

SWAP—For books on electrical engineering, radio, electronics, math. or physics, I will swap unboxed lock-in tubes. H. F. Wischnia, 513B. Tulip Rd., State College, Pa.

SWAP — Remington portable typewriter, good cond., for tube checker in working condition or? G. E. Cline, Box 701, Emmett, Idaho

FOR SALE—Radio service and ham surplus: tube tester, 3 transmitters, amplifier, 100 kc crystal, panaramascope, motors, meters, transformers, etc. No swaps. Wayne Storch, Beecher, Ill.

FOR SALE—Motorola Airboy trans./rcvr. model AT-96-25 for light aircraft, \$25. '46 Ford Mercury custom radio, \$25. Sid Biederman, c/o Silber, 640 Riverside Dr., New York, N. Y.

FOR SALE—Complete radio and TV service. Housing suitable for small family. Only repair shop in small community. Good living. Reasonable. E. J. Sayers, Sr., 30 N. Stenton Pl., Atlantic City, N. J.

FOR SALE—Transvision 12" TV set, no cabinet, any tube from 12" to 15" tube can be used without changes. Guaranteed perfect. Best cash offer. S. J. Lonigro, 52 Willowdale Ave., Montclair, N. J.

WANTED—Test equipment, sweep generator, multimeter, oscilloscope, conductance tube tester. J. Bazewick, 3000 No. Christiana, Chicago 18, Ill.

SELL OR SWAP—Complete radio and TV course, complete with questions, answers. Also many radio parts. Best offer. Bryce Whitla, 1227 No. 33, Lincoln, Neb.

FOR SALE—Wireway wire recorder with microphone, 2 half-hour spools of wire, provision for playing records, broadcasting over radio from mike phono or wire recorder, and P. A., \$68. Thomas Langdon, Rt. 1, Collingsville, Ill.

WANT—Army Sig. Corps voltohmmeter, in good condition, or information where I can secure one. P. C. Haley, P. O. Box 21, Dunkirk, Ind.

SELL OR SWAP — Complete DeForest's course on Radio Sound and TV. Best offer takes. Edward Litwin, 15791 Dexter, Detroit 21, Mich.

SWAP—Meck T60 transmitter, BC 375E, new Weston dry type photo cell, Weston microrelay for same, PBV2 Navy Ultra portable receiver transmitter. Want ham or photo gear, etc. L. Meister, 1526 Schley St., Hillside, N. J.

WANT—Riders manuals 15 through 19. Cash or will trade new G.E. radio. Case Electric, Calistoga, Calif.

TRADE—A complete Speed Graphic outfit, 4 by 5, for what have you in servicing equipment? Need oscilloscope, tube tester, sig. gen., VTVM. Al Feinberg, 154 E. 175 St., Bronx 57, N. Y.

WANT—Leica camera. Have Precision E-200 sig. gen., Solar CF-160 Exameter, and RCP tube tester with roll chart. P. Patterson, 615 Blair St., Hollidaysburg, Pa.

FOR SALE—Riders manuals, vols. 1-13, perfect condition, \$100. Sam Friedman, Box 449, Woodridge, N. Y.

FOR SALE—Philco 7050 tube checker, Sam's Photofact folders 1 to 10 in binder, both in perfect condition. Make offer. E. O. Norman, 2021 N. Houston, Ft. Worth 6, Tex.

WANT—Radio City model 777 Dynatracer, good condition. State price or will swap for Hallicrafter S-38 in original packing case. Julio Bellber Arroyo, c/o Pan American Airways, San Juan, P. R.

FOR SALE—NRI Radio-TV course with answers and 5 vol. Coyne's Applied Practical Radio (new), all for \$50. Sterling Tucker, 1502 Conoga St., Norfolk 6 Va.

WANT—6 volt, low power, marine transmitter and/or receiver. I. J. Chapel, 916 So. Blvd., New York 59, N. Y.

FOR SALE—Garod, model M33LW, 7 tubes, 3 band, AC-DC, small table model, in excellent cond. Complete with tubes in operating cond., \$12 C.O.D. V. Kozma, 3104 Wilkinson Ave., New York 61, N. Y.

SELL OR TRADE—7 x 50 Bush and Lomb binoculars, also 20X Argus Super Scope. Need testing equip. Joseph Golab, 723 Garfield Ave., Jersey City 5, N. J.

FOR SALE—National NC173 Communications Receiver and Speaker with Hammarlund 100KC frequency standard; excellent cond., \$135. Remington typewriter (portable), Envoy model, excell. cond., \$25. Martin Herbstman, 1806 Sterling Pl., Brooklyn 33, N. Y.

FOR SALE—Six 15" Major TV sets complete with all tubes and cabinets. Includes 4 Dumont 15AP4's, requires minor L. V. power supply repairs. Make offer for whole or part. Jeff Feibleman, 3413 Carondelet St., New Orleans, La.

WANT—Sperti Handi-Talkie in perfect condition. Have many valuable items. G. Samkolsky, 527 Bedford Ave., Brooklyn 11, N. Y.

WANT—Mine detector in good condition or plans for same. Will pay cash. Bauneg Beg Radio & Electrical Shop, P. O. 281, Sanford, Me.

FOR SALE—2 G. E. No. 50 type, power triodes. Any offer accepted. A. M. Vitale, Union and Chestnut Sts., Vineland, N. J.

WANT—National Radio School radio, TV course, excluding the experiments. Dar Kulp Radio Service, 125 E. 3rd St., Lewistown, Pa.

FOR SALE—Capitol Radio Engineering course. Friendly Radio Service, 18 High St., Taunton, Mass.

SELL OR TRADE—Supreme model 504A multi-tube tester, cost \$86, good condition. Will sell at best offer or swap for Heathkit scope. Sam Small, 1043 Manor Ave., Bronx 59, N. Y.

FOR SALE—Webster wire recorder, cost \$150. Also 10 rolls unused wire, \$90. F.O.B. Detroit. W. Anderson, 2990 Helen Ave., Detroit 7, Mich.

SELL OR TRADE—2 G. E. d. c. 110v. motors 1/6 and 1/3 h. p., continuous duty type Write for information. Sidney Katz, 1050 Longfellow Ave., Bronx 59, N. Y.

FOR SALE—Approved model A-200 sig. gen., used less than 2 hours. Best offer or will trade for good oscilloscope. Also latest Sprayberry Radio and TV course, complete. H. C. Scheiderer, R. 5, Box 47, Marysville, Ohio

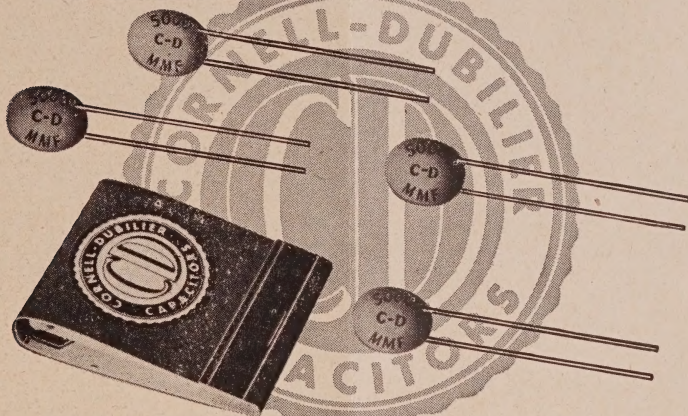
FOR SALE—Signal Corps type I-222 sig. gen., range 8-15, 150-230 Mc fundamental, \$45 f.o.b. Arthur Koehler, 130 Wadsworth Ave., New York 33, N. Y.

WANT—Test equipment, any kind. Will trade Thordason power transformer 3120 v at 2500 at 200 mills; have transmitter rack. Will trade Superior 670 for VTVM or what have you? S. Katz, 1050 Longfellow Ave., Bronx 59, N. Y.

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